Claims

What is claimed:

1. A semiconductor device, comprising:

a drain electrode;

a source electrode;

a channel contacting the drain electrode and the source electrode, wherein the channel includes a first binary oxide and a second binary oxide selected from a first group of CdO, SrO, CaO, and MgO;

a gate electrode; and

a gate dielectric positioned between the gate electrode and the channel.

2. The semiconductor device of claim 1, wherein when the first binary oxide is selected from SrO and CaO, the second binary oxide is selected from CdO, ZnO and MgO.

3. The semiconductor device of claim 2, wherein the channel includes an atomic composition of a first metal (A):second metal (B) ratio (A:B), wherein A and B are each in a range of about 0.05 to about 0.95.

4. The semiconductor device of claim 1, wherein the first group includes ZnO, and the channel includes a third binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

5. The semiconductor device of claim 4, wherein the channel includes the first binary oxide, the second binary oxide, the third binary oxide, and a fourth binary oxide selected from within the first group ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

6. The semiconductor device of claim 1, wherein the channel includes the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO and a second group of In_2O_3 and Ga_2O_3.

7. The semiconductor device of claim 6, wherein the channel includes the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO, the second group of In_2O_3 and Ga_2O_3, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2.

8. The semiconductor device of claim 7, wherein the channel includes the first binary oxide, the second binary oxide, and a third binary oxide selected from within the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

9. The semiconductor device of claim 8, wherein the channel includes the first binary oxide, the second binary oxide, the third binary oxide, and a fourth binary oxide selected from within the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

10. The semiconductor device of claim 1, wherein the channel includes one of an amorphous form, a single-phase crystalline form, and a mixed-phase crystalline form.

11. The semiconductor device of claim 1, wherein at least one of the drain electrode, the source electrode, the channel, and gate electrode, and the gate dielectric are substantially transparent.

12. A semiconductor device, comprising:

a drain electrode;

a source electrode;

means for a channel to electrically couple the drain electrode and the source electrode;

a gate electrode; and

a gate dielectric positioned between the gate electrode and the channel.

13. The semiconductor device of claim 12, means for a channel includes a first binary oxide and a second binary oxide selected from a first group of CdO, SrO, CaO, and MgO.

14. The semiconductor device of claim 13, wherein the means for the channel includes an atomic composition of a first metal(A):second metal (B) ratio (A:B), wherein A and B are each different and each in a range of about 0.05 to about 0.95.

15. The semiconductor device of claim 13, wherein the first group includes ZnO, and the means for the channel includes a third binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

16. The semiconductor device of claim 15, wherein the means for a channel includes the first binary oxide, the second binary oxide, the third binary oxide, and a fourth binary oxide selected from within the first group ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

17. The semiconductor device of claim 12, wherein the means for a channel includes a first binary oxide and a second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO and a second group of In_2O_3 and Ga_2O_3.

18. The semiconductor device of claim 12, wherein the means for a channel includes a first binary oxide and a second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO, the second group of In_2O_3 and Ga_2O_3, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2.

19. The semiconductor device of claim 18, wherein the means for a channel includes the first binary oxide, the second binary oxide, and a third binary oxide selected from within the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

20. The semiconductor device of claim 19, wherein the means for a channel includes the first binary oxide, the second binary oxide, the third binary oxide, and a fourth binary oxide selected from within the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

21. The semiconductor device of claim 12, wherein the channel includes one of an amorphous form, a single-phase crystalline form, and a mixed-phase crystalline form.

22. The semiconductor device of claim 12, wherein at least one of the drain electrode, the source electrode, the channel, and gate electrode, and the gate dielectric are substantially transparent.

23. A method of forming a semiconductor device, comprising:

providing a drain electrode;

providing a source electrode;

depositing a channel contacting the drain electrode and the source electrode, wherein the channel includes a first binary oxide and a second binary oxide selected from a first group of CdO, SrO, CaO, and MgO;

providing a gate electrode; and

providing a gate dielectric positioned between the gate electrode and the channel.

24. The method of claim 23, wherein depositing the channel includes providing a precursor composition including the first binary oxide and the second binary oxide selected from the first group of CdO, SrO, CaO, and MgO.

25. The method of claim 24, wherein the first group includes ZnO, and providing the precursor composition includes selecting the first binary oxide from SrO and CaO, then selecting the second binary oxide from CdO, ZnO and MgO.

26. The method of claim 25, wherein providing the precursor composition includes providing the precursor composition having an atomic composition of a first metal(A):second metal (B) ratio (A:B), wherein A and B are each different and each in a range of about 0.05 to about 0.95.

27. The method of claim 24, wherein the first group includes ZnO, and providing the precursor composition includes providing a third binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

28. The method of claim 27, wherein providing the precursor composition includes providing a fourth binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

29. The method of claim 23, wherein providing the precursor composition includes providing the first binary oxide and the second binary oxide selected

from within one of the first group of CdO, SrO, CaO, and MgO and a second group of In_2O_3 and Ga_2O_3.

30. The method of claim 23, wherein providing the precursor composition includes providing the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO, the second group of In_2O_3 and Ga_2O_3, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2.

31. The method of claim 30, wherein providing the precursor composition includes providing the first binary metal oxide, the second binary metal oxide, and a third binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

32. The method of claim 31, wherein providing the precursor composition includes providing the first binary metal oxide, the second binary metal oxide, the third binary oxide, and a fourth binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal: fourth metal ratio of A:B:C:D, wherein A, B, C and D are each different and each in a range of about 0.017 to about 0.95.

33. The method of claim 23, wherein depositing the channel:

vaporizing a precursor composition; and

depositing the vaporized precursor composition using a physical vapor deposition technique.

34. The method of claim 33, wherein the physical vapor deposition technique includes one or more of dc sputtering, rf sputtering, magnetron sputtering, and ion beam sputtering.

35. The method of claim 23, wherein depositing the channel includes depositing a precursor composition with an ink-jet deposition technique.

36. The method of claim 23, including providing a substrate or substrate assembly; and

forming the semiconductor device on the substrate or substrate assembly.

37. A method of manufacturing a semiconductor device, comprising:

providing a drain electrode;

providing a source electrode;

step for providing a precursor composition including a first binary oxide and a second binary oxide selected from a first group of CdO, SrO, CaO, and MgO;

step for depositing a channel from the precursor composition between and electrically coupling the drain electrode and the source electrode;

providing a gate electrode; and

providing a gate dielectric positioned between the gate electrode and the channel.

38. The method of claim 37, wherein the step of providing a precursor composition includes a step of selecting a first binary oxide from SrO and CaO, then selecting the second binary oxide from CdO, ZnO and MgO.

39. The method of claim 38, wherein the step for providing the precursor composition includes providing the precursor composition having an atomic composition of a first metal(A):second metal (B) ratio (A:B), wherein A and B are each different and each in a range of about 0.05 to about 0.95.

40. The method of claim 37, wherein the first group includes ZnO, and the step for providing the precursor composition includes providing a third binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

41. The method of claim 37, wherein the step for providing the precursor composition includes step for providing the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO and a second group of In_2O_3 and Ga_2O_3.

42. The method of claim 37, wherein the step for providing the precursor composition includes step for providing the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO, the second group of In_2O_3 and Ga_2O_3, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2.

43. The method of claim 42, wherein the step for providing the precursor composition includes providing the first binary metal oxide, the second binary metal oxide, and a third binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

44. The method of claim 43, wherein the step for providing the precursor composition includes providing the first binary metal oxide, the second binary metal oxide, the third binary oxide, and a fourth binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal: fourth metal ratio of A:B:C:D, wherein A, B, C and D are each different and each in a range of about 0.017 to about 0.95.

45. The method of claim 37, wherein the step for forming a channel includes:

step for vaporizing the precursor composition to form vaporized precursor composition; and

depositing the vaporized precursor composition using a physical vapor deposition technique.

46. The method of claim 37, wherein the step for depositing the channel includes step for depositing the precursor composition with an ink-jet deposition technique.

47. A method of forming a channel, comprising:

providing a precursor composition including a first binary oxide and a second binary oxide selected from a first group of CdO, SrO, CaO, and MgO; and

depositing the channel from the precursor composition between and electrically coupling a drain electrode and a source electrode.

48. The method of claim 47, wherein the first group includes ZnO, and providing a precursor composition includes selecting the first binary oxide from SrO and CaO, then selecting the second binary oxide from CdO, ZnO and MgO.

49. The method of claim 48, wherein providing the precursor composition includes providing the precursor composition having an atomic composition of a first metal(A):second metal (B) ratio (A:B), wherein A and B are each different and each in a range of about 0.05 to about 0.95.

50. The method of claim 47, wherein the first group includes ZnO, and providing the precursor composition includes providing a third binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

51. The method of claim 50, wherein providing the precursor composition includes providing a fourth oxide semiconductor from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C and D are each different and each in a range of about 0.017 to about 0.95.

52. The method of claim 47, wherein the step for providing the precursor composition includes step for providing the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO and a second group of In_2O_3 and Ga_2O_3.

53. The method of claim 47, wherein providing the precursor composition includes step for providing the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO, the second group of In_2O_3 and Ga_2O_3, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2.

54. The method of claim 53, wherein providing the precursor composition includes providing the first binary metal oxide, the second binary metal oxide, and a third binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

55. The method of claim 54, wherein providing the precursor composition includes providing the first binary metal oxide, the second binary metal oxide, the third binary oxide, and a fourth binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal: fourth metal ratio of A:B:C:D, wherein A, B, C and D are each different and each in a range of about 0.017 to about 0.95.

56. A semiconductor device formed by the steps, comprising:

providing a drain electrode;

providing a source electrode;

providing a precursor composition including a first binary oxide and a second binary oxide selected from a first group of CdO, SrO, CaO, and MgO;

depositing a channel from the precursor composition contacting the drain electrode and the source electrode;

providing a gate electrode; and

providing a gate dielectric positioned between the gate electrode and the channel.

57. The method of claim 56, wherein providing a precursor composition includes selecting a first binary oxide from SrO and CaO, then selecting the second binary oxide from CdO, ZnO and MgO.

58. The semiconductor device of claim 57, wherein providing the precursor composition includes step for providing the precursor composition having an atomic composition of a first metal(A):second metal (B) ratio (A:B), wherein A and B are each different and each in a range of about 0.05 to about 0.95.

59. The semiconductor device of claim 56, wherein the first group includes ZnO, and providing the precursor composition includes step for providing a third binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

60. The semiconductor device of claim 59, wherein providing the precursor composition includes step for providing a fourth binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

61. The semiconductor device of claim 56, wherein providing the precursor composition includes step for providing the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO and a second group of In_2O_3 and Ga_2O_3.

62. The semiconductor device of claim 56, wherein providing the precursor composition includes step for providing the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and

MgO, the second group of In_2O_3 and Ga_2O_3, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2.

63. The semiconductor device of claim 62, wherein providing the precursor composition includes step for providing the first binary metal oxide, the second binary metal oxide, and a third binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

64. The semiconductor device of claim 63, wherein providing the precursor composition includes providing the first binary metal oxide, the second binary metal oxide, the third binary oxide, and a fourth binary oxide from the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal: fourth metal ratio of A:B:C:D, wherein A, B, C and D are each different and each in a range of about 0.017 to about 0.95.

65. The semiconductor device of claim 56, wherein forming a channel includes:

step for vaporizing the precursor composition to form vaporized precursor composition; and

depositing the vaporized precursor composition using a physical vapor deposition technique.

66. A method for operating a semiconductor device, comprising:

providing a semiconductor device that includes a drain electrode, a source electrode, a channel to electrically couple the drain electrode and the source electrode, wherein the channel includes a first binary oxide and a second binary oxide selected from within one of a first group of CdO, SrO, CaO, and MgO, a second group of In_2O_3 and Ga_2O_3, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2, a gate electrode, and a gate dielectric positioned between the gate electrode and the channel; and

applying a voltage to the gate electrode to effect a flow of electrons through the channel.

67. The method of claim 66, wherein providing a semiconductor device that includes a channel having a first binary oxide selected from SrO and CaO, and a second binary oxide selected from CdO, ZnO and MgO.

68. The method of claim 66, wherein applying a voltage includes using the semiconductor device as a switch in a display device.

69. The method of claim 66, wherein applying a voltage includes conducting electrons through the channel in a linear region of operation.

70. A display device, comprising:

a plurality of display elements configured to operate collectively to display images, where each of the display elements includes a semiconductor device configured to control light emitted by the display element, the semiconductor device including:

a drain electrode;

a source electrode;

a channel contacting the drain electrode and the source electrode, wherein the channel includes a first binary oxide and a second binary oxide selected from a first group of CdO, SrO, CaO, and MgO;

a gate electrode; and

a gate dielectric positioned between the gate electrode and the channel and configured to permit application of an electric field to the channel.

71. The display device of claim 70, wherein when the first binary oxide is selected from SrO and CaO, the second binary oxide is selected from CdO, ZnO and MgO.

72. The display device of claim 71, wherein the channel includes an atomic composition of a first metal(A):second metal (B) ratio (A:B), wherein A and B are each different and each in a range of about 0.05 to about 0.95.

73. The display device of claim 70, wherein the first group includes ZnO, and the channel includes a third binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

74. The display device of claim 73, wherein the channel includes a fourth binary oxide from the first group of ZnO, CdO, SrO, CaO, and MgO and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

75. The display device of claim 70, wherein the channel includes the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO and a second group of In_2O_3 and Ga_2O_2.

76. The display device of claim 70, wherein the channel includes the first binary oxide and the second binary oxide selected from within one of the first group of CdO, SrO, CaO, and MgO, the second group of In_2O_3 and Ga_2O_2, and a third group of SnO_2, GeO_2, PbO_2, and TiO_2.

77. The display device of claim 76, wherein the channel includes the first binary oxide, the second binary oxide, and a third binary oxide selected from within the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal ratio of A:B:C, wherein A, B, and C are each different and each in a range of about 0.025 to about 0.95.

78. The display device of claim 77, wherein the channel includes the first binary oxide, the second binary oxide, the third binary oxide, and a fourth binary

oxide selected from within the third group SnO_2, GeO_2, PbO_2, and TiO_2 and having an atomic composition of a first metal:second metal:third metal:fourth metal ratio of A:B:C:D, wherein A, B, C, and D are each different and each in a range of about 0.017 to about 0.95.

79. The display device of claim 78, wherein at least one of the drain electrode, the source electrode, the channel, and gate electrode, and the gate dielectric are substantially transparent.